

WHAT IS CLAIMED IS:

1. A fuel cell comprising;  
an anode electrode;  
a cathode electrode; and  
5 a third electrode interposed between the anode and the cathode  
electrodes.
2. The fuel cell according to claim 1, wherein the third electrode is a reference electrode.
3. The fuel cell according to claim 1, wherein the third electrode and at 10 least one of the anode and cathode electrodes are coupled to an electrical apparatus.
4. The fuel cell according to claim 3, wherein the electrical apparatus is a voltage or current source.
5. The fuel cell according to claim 3, wherein the electrical apparatus is an electrical measurement device.
- 15 6. The fuel cell according to claim 1, wherein the third electrode is used to control processes of at least one of the following: the anode and the cathode electrodes.
7. The fuel cell according to claim 6, wherein the processes include at least one of the following: thermodynamic, chemical, kinetic, and transport 20 phenomena.
8. The fuel cell according to claim 1, wherein the third electrode is used to monitor the health of any component of the fuel cell.
9. The fuel cell according to claim 8, wherein a component of the third electrode conducts electrons.
- 25 10. The fuel cell according to claim 1, wherein the third electrode includes a material that permits ions of the electrochemical couple to be transported past, or conducted through, its interposition.
11. The fuel cell according to claim 1, wherein the third electrode includes at least one of the following: a polymer and a polymer composite.
- 30 12. The fuel cell according to claim 11, wherein the third electrode includes an electrically conductive component.
13. The fuel cell according to claim 1, wherein the third electrode includes at least one of the following: a metallic and a polymer grid, or a conducting polymer.

14. The fuel cell according to claim 1, wherein the third electrode includes a material that, when coupled with the anode or cathode electrodes of the fuel cell, produces an electromotive force (e.m.f.) without the advent of an external voltage source.

5 15. The fuel cell according to claim 1, further including at least one of the following fuel couple: substantially pure hydrocarbons, methanol, hydrazine, reformed ammonia, natural gas, and molten carbonate.

16. The fuel cell according to claim 1, further including an electrolyte.

10 17. The fuel cell according to claim 16, wherein the electrolyte is a polymer solid electrolyte.

18. The fuel cell according to claim 16, wherein the electrolyte includes at least one of the following: a solid oxide, phosphoric acid, and alkaline.

19. A method of manufacturing a fuel cell, comprising:

forming an anode electrode;

15 forming a cathode electrode;

forming an electrolyte material;

depositing a thin film of an electrically conductive metal or conducting polymer to a reference electrode; and

sandwiching the reference electrode and electrolyte material between the anode and cathode electrodes.

20 20. The method according to claim 19, wherein the reference electrode includes a membrane.

21. The method according to claim 20, wherein the membrane is a polymer membrane.

25 22. A method for operating a fuel cell, comprising:

applying an interactive feedback system to control the state of hydration of the ionomer membrane utilizing an electrode other than an anode or cathode electrode.

30 23. The method according to claim 22, wherein the interactive feedback system regulates the fuel cell.

24. The method according to claim 22, wherein the interactive feedback system further monitors electrochemical processes at the anode or cathode.

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